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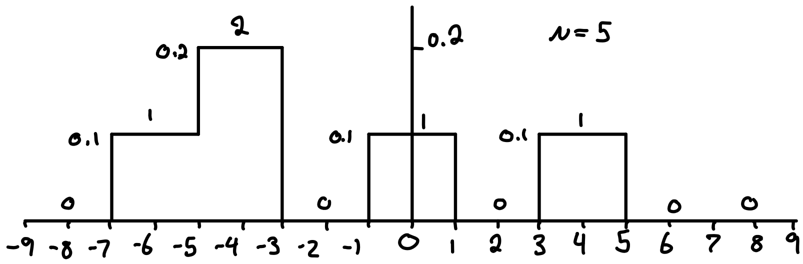
PHYS 252 HW 4

Problem 1

After	Bin (-9,-7)	(-7,-5)	(-5,-3)	(-3,1)	(-1,1)	(1,3)	(3,5)	(5,7)	(7,9)
(a) 5 trials	0	1	2	0	1	0	1	0	0
(b) 10 trials	0	1	2	2	3	1	1	0	0
(c) 50 trials	1	3	7	8	10	9	6	4	2

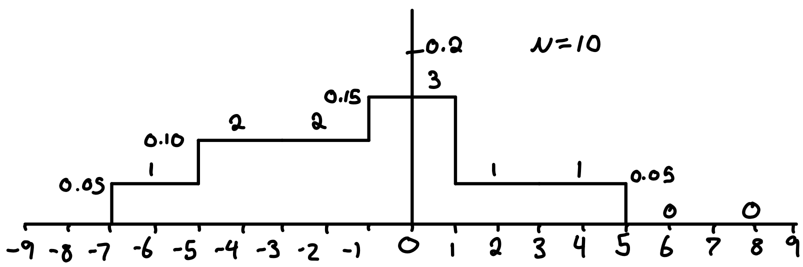
a.)



$$\frac{\text{Result}}{\text{Bin} \cdot \sigma_x}$$

$$\frac{1}{5 \cdot 2} = 0.1 \qquad \frac{2}{5 \cdot 2} = 0.2$$

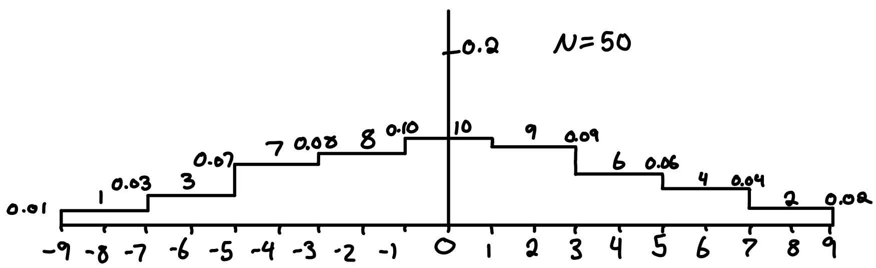
b.)



$$\frac{1}{10 \cdot 2} = 0.05 \qquad \frac{2}{10 \cdot 2} = 0.1$$

$$\frac{3}{10 \cdot 2} = 0.15$$

c.)



$$\frac{1}{50 \cdot 2} = 0.01 \qquad \frac{3}{50 \cdot 2} = 0.03$$

$$\frac{7}{50 \cdot 2} = 0.07 \qquad \frac{8}{50 \cdot 2} = 0.08$$

$$\frac{10}{50 \cdot 2} = 0.1 \qquad \frac{9}{50 \cdot 2} = 0.09$$

$$\frac{6}{50 \cdot 2} = 0.06 \qquad \frac{4}{50 \cdot 2} = 0.04$$

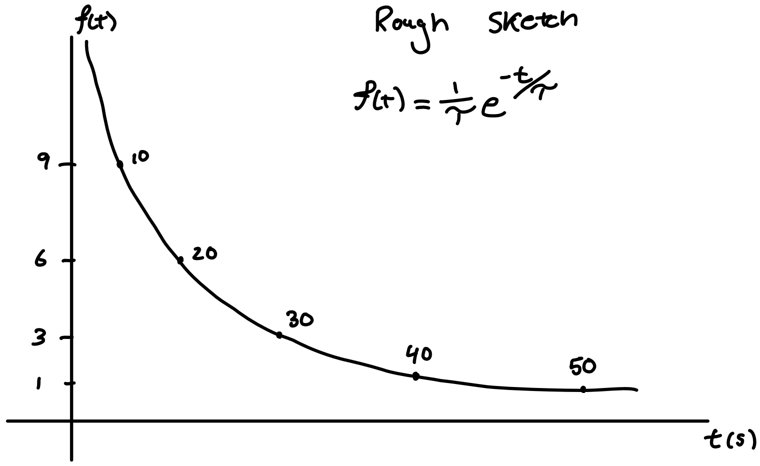
$$\frac{2}{50 \cdot 2} = 0.02$$

Problem 2

a.)

Rough sketch

$f(t) = \frac{1}{\tau} e^{-t/\tau}$



b.) $f(t) = \frac{1}{\tau} e^{-t/\tau}$ $\int_0^{\infty} f(t)\, dt = 1$

can't have negative time

$\int f(t)\, dt = -e^{-t/\tau} \Big|_0^{\infty}$

$\lim_{t \to \infty} -e^{-t/\tau} = 0 \Big|^{\infty}$ $-e^{-t/\tau}$ $t = 0 \Big|_0$

$-e^0$

$= -1$

$0 - (-1) = 1$

From the above work, we can say

$$\int_0^{\infty} f(t)\, dt = \lim_{t \to \infty} -e^{-t/\tau} - (-e^{-t/\tau}) \Big|_0$$

$$= 0 - (-1)$$

$$\int_0^{\infty} f(t)\, dt = 1$$

$$\boxed{\int_{-\infty}^{\infty} f(t) = 1}$$

c.) $\bar{t} = \int_{-\infty}^{\infty} t f(t)\, dt$ $f(t) = \frac{1}{\tau} e^{-t/\tau}$

$\bar{t} = \int_0^{\infty} \frac{t}{\tau} e^{-t/\tau}\, dt$ $uv - \int v\, du$ $u = t$ $dv = e^{-t/\tau}$

$du = 1\,dt$ $v = -\tau e^{-t/\tau}$

$= 1/\tau \int_0^{\infty} t e^{-t/\tau}\, dt$

$= 1/\tau \left(-\tau t e^{-t/\tau} - \int -\tau e^{-t/\tau}\, dt\right)$

$= 1/\tau \left(-\tau t e^{-t/\tau} + \tau \int e^{-t/\tau}\, dt\right)$

$= 1/\tau \left(-\tau t e^{-t/\tau} + \tau(-\tau e^{-t/\tau}) \Big|_0^{\infty}\right)$

$= 1/\tau \left(-\tau t e^{-t/\tau} - \tau^2 e^{-t/\tau} \Big|_0^{\infty}\right)$

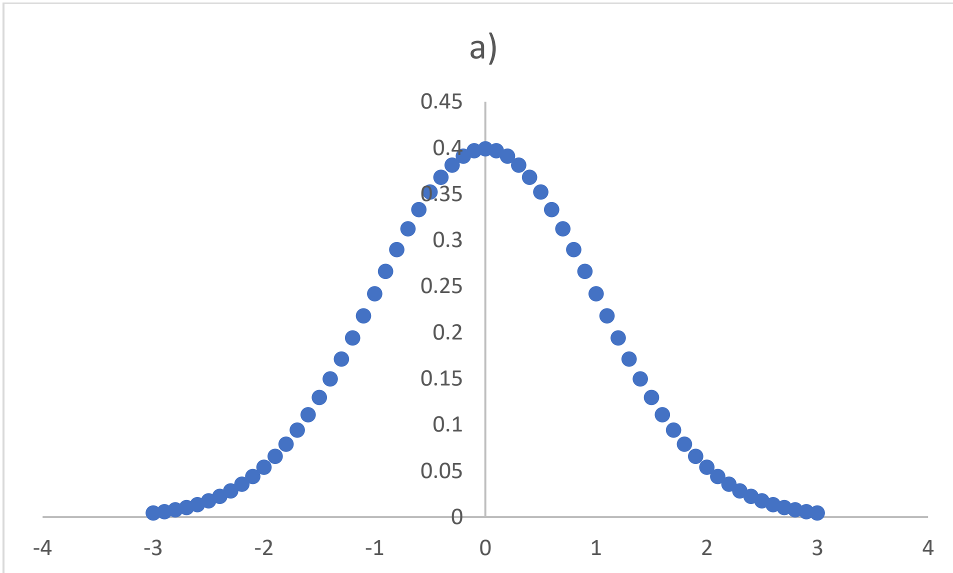
$= 1/\tau \left((0-0) - \tau^2(0-1)\right)$

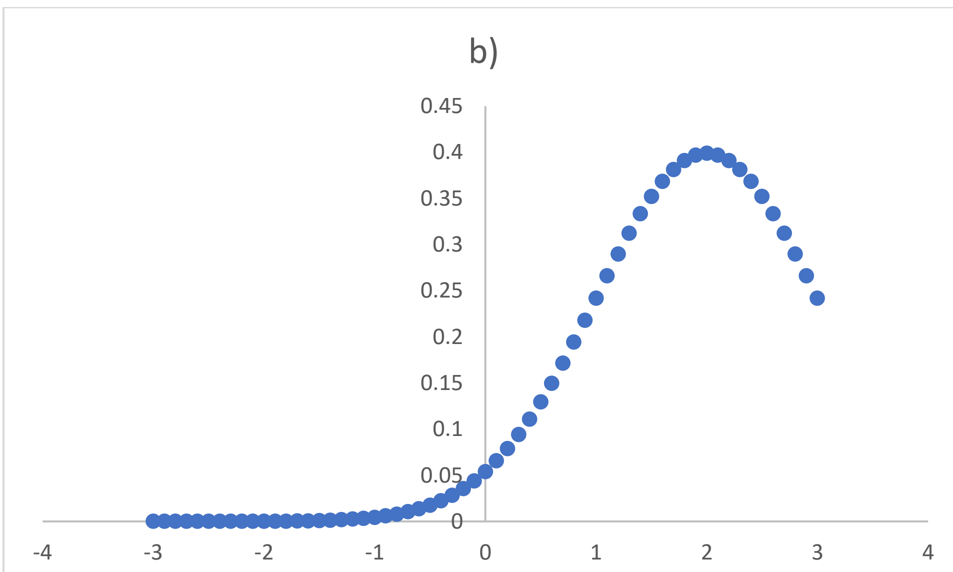
$= 1/\tau (\tau^2)$

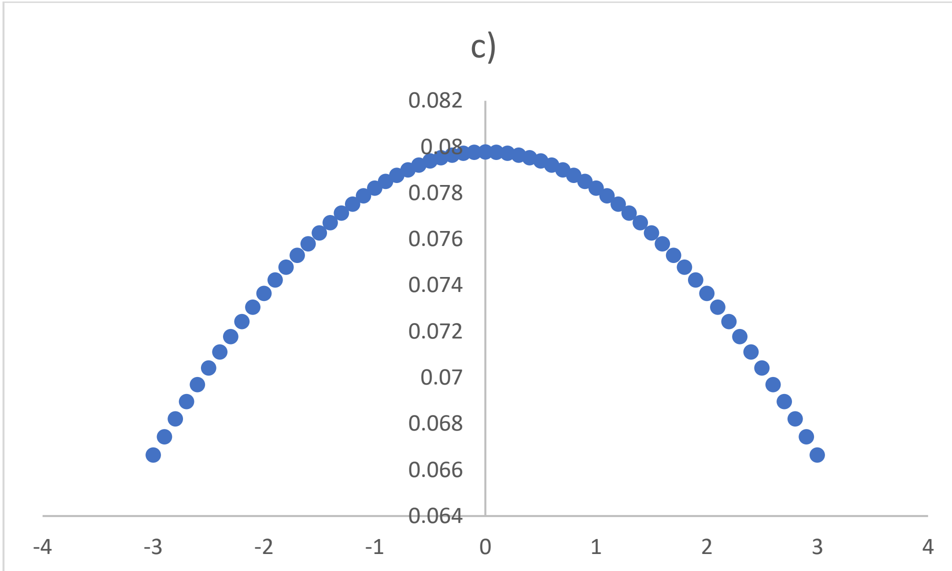
$\bar{t} = \tau$

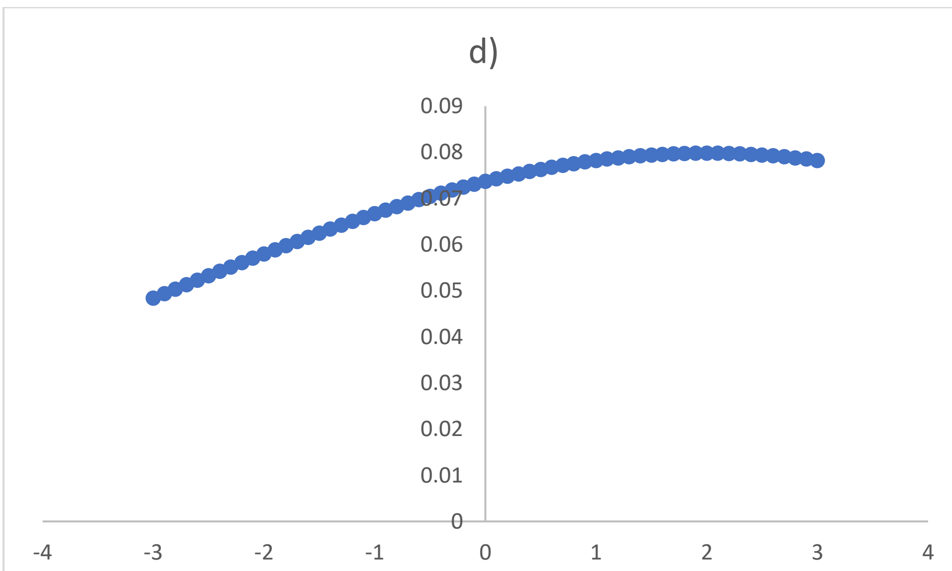
$$\boxed{\bar{t} = \tau}$$

Problem 3


a)
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
-4
-3
-2
-1
0
1
2
3
4


b)
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
-4
-3
-2
-1
0
1
2
3
4





e.) It shifts the peak of the curve, from its original position, "0", to be centered on its new position, "2". x_0 changes position of curve.

f.) The curve of the distribution flattens as it gets bigger. σ changes the curve of the curve.

Problem 4

$F(x) = K \cdot e^{-x^2/2\sigma_x^2}$

HWHM

$K/2$

$\frac{K}{2} = Ke^{-x^2/2\sigma_x^2}$

$\frac{1}{2} = e^{-x^2/2\sigma_x^2}$

$\ln(1/2) = \frac{-x^2}{2\sigma_x^2}$

$-2\sigma_x^2 \ln(1/2) = x^2$

$\sigma_x^2 2\ln(2) = x^2$

$x = \sigma_x \sqrt{2\ln(2)}$

$x = 1.17\sigma_x$

FWHM

$FWHM = 2\, HWHM$

$= 2(1.17\sigma_x)$

$= 2.34\sigma_x$

$\boxed{FWHM = 2.34\sigma_x}$

Problem 5

a.) With the aide of xcel, the mean of this data set was,

$\boxed{\begin{array}{l} \text{mean} = 8.15 \\ \text{SDEV} = 0.039 \end{array}}$

b.) With the aid of excel, the averages of the ten data sets are,

Data set of (3)	Average
1	8.140
2	8.147
3	8.180
4	8.180
5	8.187
6	8.137
7	8.093
8	8.110
9	8.177
10	8.143

C.) Expected SDEV,

SDEV : $\bar{\sigma}_x = \dfrac{\sigma_x}{\sqrt{10}} = \dfrac{0.039}{\sqrt{10}} = 0.0123$

$\boxed{\begin{array}{l} \text{Expected} : 0.012 \\ \text{Excel} : 0.010 \end{array}}$

With excel : $0.0099 \simeq 0.010$

d.)

8.06 (1)	8.09 (1)
8.09 (1)	8.11 (1)
8.10 (3)	8.14 (3)
8.12 (4)	8.15 (1)
8.13 (1)	8.18 (3)
8.14 (4)	8.19 (1)
8.16 (6)	$\sigma = 0.01$
8.17 (2)	Bin = 3
8.18 (5)	
8.21 (2)	
8.24 (1)	
$\sigma = 0.01$	
Bin = 30